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HOUSEHOLD PROTEIN INTAKE AND DISTRIBUTION OF PROTEIN SOURCES IN THE MARKETS OF SOUTHERN GHANA: A PRELIMINARY REPORT

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ABSTRACT This paper describes protein intake in the forest areas of southern Ghana. The paper is based on research conducted at markets and observation of meals at households. The protein sources have changed due to the natural and economical environment in the area. Primary protein sources are wild animals, fish, livestock, and beans. Deforestation due to cacao field expansion and some other reasons decreased the number of animals hunted in the forest. We studied what protein sources are distributed at markets, where they are produced (local or outside production), which protein sources households consume, how they are cooked, and cultural values. Results indicate that fish is a primary protein source. Frozen, sun-dried, smoked, and salted marine and freshwater fish are widely distributed, depending on the development of truck transportation. Therefore, it seems that the self-sufficiency of protein sources in local areas has decreased. Analyzing the case of Ghana is important in terms of considering the future of central Africa's forest areas.

Key Words: Protein intake; Forest; Southern Ghana; Fish; Wild meat.

INTRODUCTION

This paper describes the status of protein intake and distribution of protein sources in southern Ghana to compare available ingredients in forest areas of western Africa to those in central Africa.

Agriculture and food in Ghana is similar to that in central Africa's Congo Basin, which is the area of focus for most studies on this volume. Based on similar climates and vegetation, crops cultivated in western Africa are similar to those in the Congo Basin. Plantains and root crops such as cassava and yams are cultivated as staple foods, while tree crops such as cacao and coffee are planted as cash crops. Generally, people in central and western Africa eat a main dish accompanied by a side dish. Main dishes comprise cereals, root crops, and plantains, while common sides are saucy dishes of meat, fish, and wild plants. Most side dish ingredients are obtained out of cultivated field.

However, Ghanaian policies on agriculture and infrastructure construction differ from those in other central African countries. Ghanaian government policy on agriculture has had a large impact on the agricultural practice of small farmers. For example, Ghana's government promotes the dissemination of an improved strain of cacao. In addition to cacao, staple food and beans are also commoditized

in Ghana. Since trunk roads have been well constructed and maintained, crop distribution is well developed.

In the forest areas of southeastern Cameroon and Democratic Republic of the Congo (DRC), wild animals and fish are important protein sources. As such, local people keep these for themselves or distribute them locally. Currently, various measures are in place to protect against the shortage of protein sources due to an increasing population and decreasing number of wild animals. Measures include the introduction of river fish farming and soybean growing, as well as the expansion of poultry and pig farming (Matsuura, 2015, in this volume). An increasing population and decreasing number of wild animals occurred in western Africa earlier than in central Africa. Furthermore, the decreasing forest area is a major problem noted in Ghana's agriculture and food security policies.

Thus, considering the protein supply in Africa's forest areas, an analysis of the situation in Ghana is important, as while deforestation is a problem, food distribution is better developed than in other forest areas in Africa.

We investigated staple foods, meat, fish, and beans at markets, and observed the cooking and consumption of these foods at urban and rural households in each area. We conducted field research at Accra, the capital of Ghana (markets), the Kade area in the Eastern Region (households), New Koforidua in the Ashanti Region (household), Konongo (10 km east of New Koforidua, market), and Sunyani, the capital of the Brong-Ahafo Region (markets and household) from August 30 to September 7, 2010 and from August 14 to September 1, 2012. For markets, we recorded the types of cereals, root crops, plantains, meat, fish, and beans on offer. For households, we requested informants to cook the usual dishes eaten and asked them to explain their cooking methods, ingredients, and how frequently main ingredients are used. In the Kade area, we observed cooking procedures and recorded the ingredients and cooking methods in detail.

OVERVIEW OF SOUTHERN GHANA

The vegetation in southern Ghana can be categorized as rain forest, moist semi-deciduous forest, savanna, and coast-specific vegetation (Fig. 1). Of these, the moist semi-deciduous forest covers the widest area, the rain forest is found in the southwest, savanna-type areas are not wide reaching, and coast-specific vegetation comprises coastal shrubs, grassland, strand, and a mangrove zone (Fig. 1).

The mean annual rainfall in southern Ghana's forest area varies from 1317 mm to 2217 mm in each region (website of Interpolated Estimated Dekadal Rainfall by Region/Province, Ghana [Online 1]).

Areas suitable for cacao cultivation have an annual temperature of 21 to 32 degrees Celsius and a mean annual rainfall of 1270 mm at a minimum, where no months receive less than 63.5 mm of rain (Purseglove, 1968). Cacao can be and is cultivated throughout most of southern Ghana (Takane, 1999).⁽¹⁾ However, the primary forest area has decreased in southern Ghana, because of forest clearing for cacao fields and frequent intentional or accidental fires. The annual average

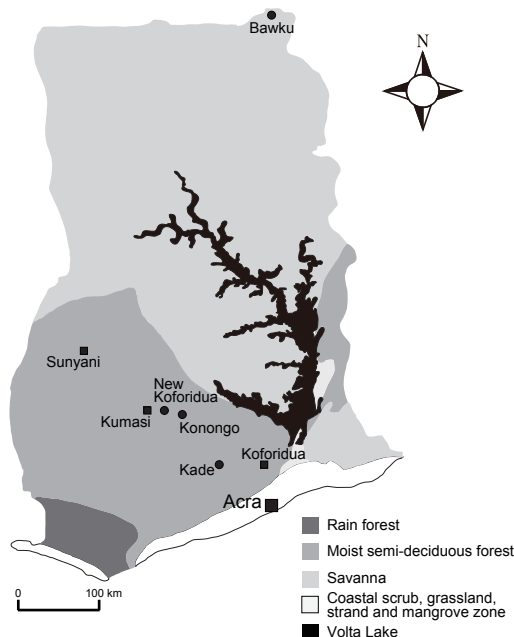


Fig. 1. Vegetation in Ghana.

Source: Website of FAO Country Pasture/Forage Resource Profiles: GHANA (Online 1).

by which Ghana's forest has decreased from 1990 to 2000 was 2.0%, and 2.1% from 2000 to 2010. These rates are higher than those for the whole of Africa (0.64% from 1990 to 2000, and 0.5% from 2000 to 2010).⁽²⁾

In 2010, Ghana's population totaled 24.7 million people, 67% of which resided in forest areas (Western, Central, Volta, Eastern, Ashanti, and Brong-Ahafo Regions) (Ghana Statistical Service, 2012).⁽³⁾

Ghana's largest language group is the Kwa group of the Niger-Congo family, which includes Akan, the major language spoken in Ghana's forest areas. However, Ga (Kwa group) speakers are majority in Accra. In addition, the Akan language has many dialects (Moseley & Asher, 1994).

The road network is highly developed in southern Ghana (Fig. 2). From the 1910s, several trunk roads were constructed from coastal to inland areas. Currently, most trunk roads are paved and frequently used by numerous trucks. Railways were constructed from Sekondi to Kumasi in 1905 and from Accra to Kumasi in 1923 to transport products for export. However, outdated trains and railways have decreased transportation capacity, and products distributed in Ghana are seldom transported by rail. Consequently, food is primarily transported by truck (Takane, 2003a).

Since the colonial period, Ghana's agricultural policy has promoted the cultivation of export crops. The colonial and Ghanaian governments regarded cacao as the most important export crop. Cacao cultivation began in the Eastern Region in the second half of the 19th century. Under British colonial rule, cacao cultivation

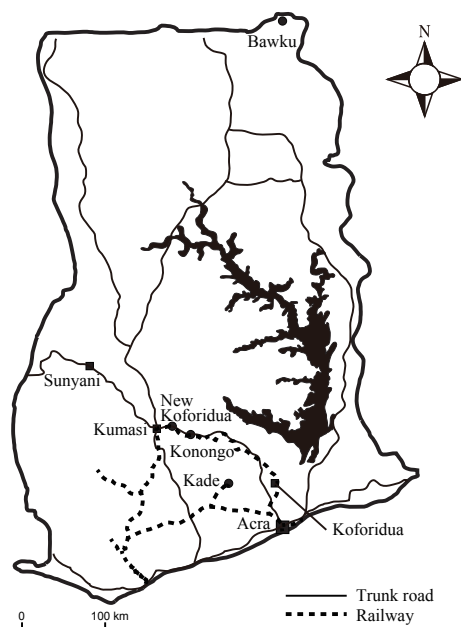


Fig. 2. Transportation and research area in Ghana.

spread throughout southern Ghana until the first half of the 20th century (Takane, 1999; 2003a). In 1960, cacao accounted for 66% of Ghana's exports (Nakamura, 1982), and is mainly produced by small farmers as a combined subsistence crop. Many people migrated to cultivate cacao and mine for gold, and as such, many migrants relocated from northern to southern Ghana (Takane, 2003b). In 1947, the Cocoa Marketing Board was founded. Since then, the colonial and Ghanaian governments controlled cacao production, pricing for farmers, permitting agents, and export. Control mechanisms have been modified several times consequent to political changes after independence, and cacao remained the Ghana's largest source of export until 1992. Currently, Ghana's government controls pricing and distribution and gives instructions regarding growing methods (Takane, 1999). Lead by the Cocoa Research Institute of Ghana (CRIG), the government adopted various policies such as the dissemination of an improved cacao cultivar for which trees providing shade were unnecessary. Furthermore, while efforts have been made to develop new exports such as pineapples, citrus, and oil palm, this has not yet been successful.

STATISTICS OF FOOD CONSUMPTION IN GHANA

Based on FAOSTAT Food Balance data (Online 2), we analyzed Ghana's average quantity of daily protein supply.⁽⁴⁾

Statistical data (Fig. 3) indicates that Ghanaians obtain more than half their protein from starchy foods such as cereals, roots, and plantains. Cereals contain more protein than roots and plantains by weight. Regarding protein content, 100 g of rice (white, polished, raw) contains 6.1 g of protein, 100 g of maize (white, whole kernel, dried, raw) contains 9.2 g, 100 g of cassava (tuber, raw) 1.2 g, 100 g of yam (tuber, raw) 1.9 g, and 100 g of plantain (ripe, raw) 1.2 g (FAO, 2012).⁽⁵⁾ Although the gross weight of cereal consumed is one sixth that of roots and plantains, protein intake is similar, because cereal has a high protein content. However, the amino acid score (an indicator of protein quality) of starchy foods is lower than that for meat, fish, and beans. Therefore, meat, fish, and beans are generally regarded as high-quality sources of protein.

While fish is the major source of protein, recently, meat and beans have become more popular as well (Fig. 4). The quantity of marine fish exceeds that of freshwater fish (Fig. 5). Most freshwater fish consumed in Ghana is caught in Ghana, and large-scale fishing is conducted at Volta Lake. In 2011, domestic production of marine fish totaled 243,800 tons, imported marine fish 334,700 tons, and exported marine fish 54,700 tons. As such, Ghanaians depend on imported marine fish as a protein source.

The most important protein source among meat is poultry (Fig. 6); however, data for “poultry” is only provided for chicken. In addition to chicken, Ghanaians eat guinea fowl, duck, and turkey (Amoako-Kwakye, 2010), meaning that the actual consumption of poultry is larger than the FAOSTAT value. Chicken production and import has rapidly increased. Domestic chicken production doubled for ten years, and the quantity of imported chicken increased 10 times for ten years. Volume of imported chicken was more than three times that of domestically produced chicken. Furthermore, beef is the second most consumed meat.

Regarding beans, groundnuts are produced and consumed the most, followed by cowpeas and soya beans (Ministry of Food and Agriculture, Republic of Ghana, 2013).

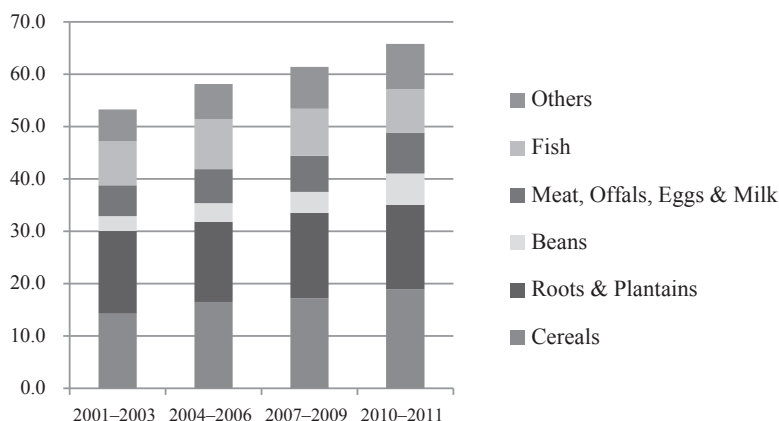


Fig. 3. Protein Supply Quantity in Ghana (g/capita/day).

Source: Website of FAOSTAT (Online 2), only beans are based on Ministry of Food and Agriculture, Republic of Ghana (2013).

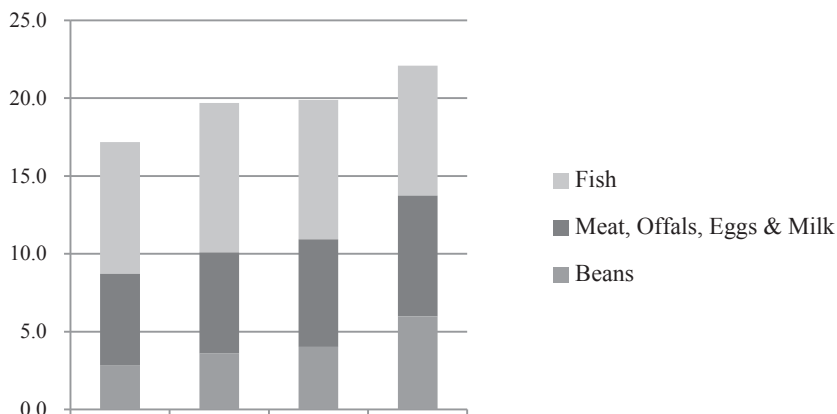


Fig. 4. Protein Supply Quantity in Ghana: meats, fish and beans (g/capita/day).

Source: Website of FAOSTAT (Online 2), only beans are based on Ministry of Food and Agriculture, Republic of Ghana (2013).

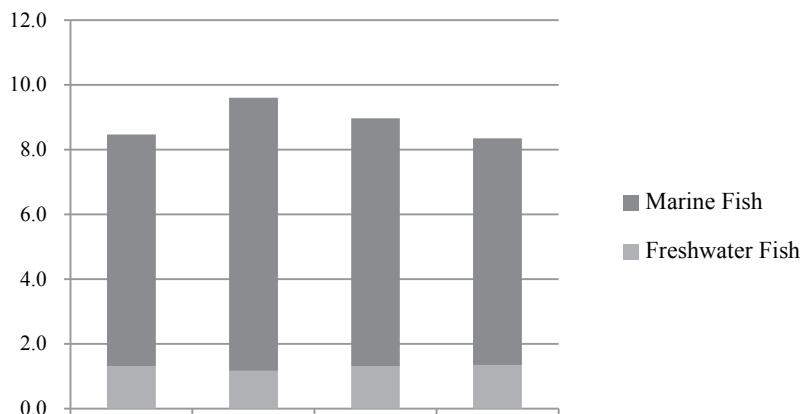


Fig. 5. Protein Supply Quantity in Ghana: meats (g/capita/day).

Source: Website of FAOSTAT (Online 2).

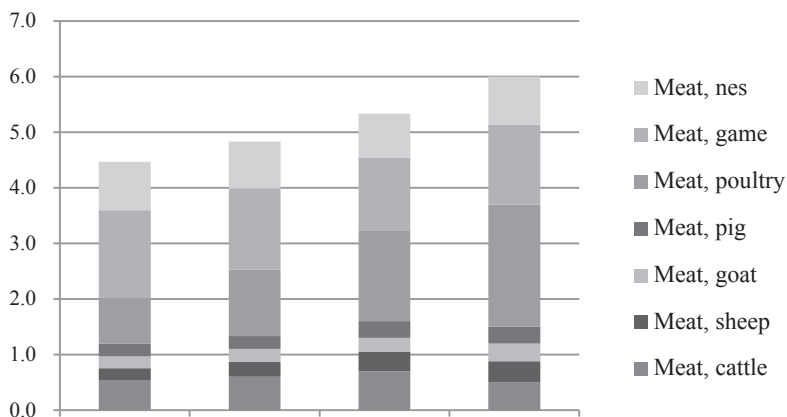


Fig. 6. Protein Supply Quantity in Ghana: fish (g/capita/day).

Source: Website of FAOSTAT (Online 2).

Although the FAOSTAT statistical data (Online 2) indicates that a large quantity of game meat is consumed in Ghana, we found only a small quantity available at markets, and informants reported that they did not frequently consume it. One reason for the scarcity of game meat at markets is that our research was conducted out of the hunting season. However, possibly, the high volume indicated in the statistical data is incorrect. Likely, the data may include domesticated grasscutters.

PROTEIN SOURCES SOLD IN MARKETS OF SOUTHERN GHANA

Markets in Accra, the Capital of Ghana

Accra, the capital of Ghana is situated on the coast (Fig. 1), the center of domestic and international food circulation. We conducted the research at two local markets (Makola market in the train station and bus station neighborhood of central Accra and Madina market in northern Accra's suburban residential area) and a high-quality supermarket in an affluent shopping mall in a suburb of Accra. We conducted field research in August 2010.

Our informant, a student in the Graduate School of Agriculture at the University of Ghana, noted that the food most eaten as a protein source by residents of Accra was fish, followed by meat, then beans. The most expensive protein source was meat, followed by fish, then beans. He added that beans were occasionally regarded as poor people's food.

Gender division of labor exists in the local market: males sell livestock meat such as beef, pork, and poultry, and females sell other fresh food.

Roots, tubers, plantains and cereals

We researched plantains and rice at the markets in Accra, finding both domestic and foreign rice on offer. We observed two types of plantain at the markets, namely *apem*—a small, hard French plantain—and *apentu*—a large, soft horn and false horn plantain. Generally, *apem* are boiled, while *apentu* are used as *fufu*.⁽⁶⁾ We also found a variety called *oniaba* which was included in *apem* type.

Although we did not record yam and cassava quantities, they are also likely sold at these markets.

We found processed food such as *gari* made from cassava and *banku*, which is made from cassava or maize. *Gari* is easily cooked, eaten for breakfast or as a snack, and a side dish ingredient. We explain cooking methods later.

Domestic and wild animals

We saw beef, pork, goat, mutton, chicken, and guinea fowl on sale at local markets. Guinea fowl are mainly produced in the dry areas of northern Ghana and Nigeria. Our informant explained that meat sold at local markets was produced in Ghana; however, the quantity of imported beef and chicken has rapidly increased (website of FAOSTAT [Online 2]). Imported meat might be sold at only the cold store (a store keeping meat and fish in a freezer).

Meat products we observed in Ghana but not in central Africa include grilled cowhide (*wele*) and pig toes, which are used in side dishes for their flavor or texture.

The supermarket in the affluent shopping mall sold beef, pork, and chicken imported from South Africa and Brazil.

For wild animals, we did not observe them in markets, but observed only meat from grasscutters in a restaurant. The grasscutter (the greater cane rat, *Thryonomys swinderianus*) is an African wild animal and considered farm vermin. However, it has recently been partly domesticated as a source of protein. Ghanaians regard it as a semi-wild and semi-domestic animal, and it is more expensive than other livestock meats.

Fish and aquatic products

Fresh fish is sold at the cold store, while smoked and salted (or processed both ways) fish is sold at local markets. The cold store sells primarily marine fish and tilapia caught through large-scale fishing operations. We found smoked marine fish such as tuna and herring, and processed (fermented, salted, and sun-dried) fish called *momoni* in local markets.

Most fish sold at the shopping mall supermarket is fresh marine fish caught by Ghanaian fishermen. During our research, we found red snapper, barracuda, sole, “fresh cassava” (croaker, Sciaenidae family of fish), sea bream (Sparidae), and octopus. We also noted fresh tilapia as the only freshwater fish.

Beans

Local markets carried several types of beans, both locally produced and imported. Domestic and imported cowpeas are widespread in Ghana. The most popular type of cowpea is referred to as the “white bean” or “normal bean.” In addition, named after the countries where they are produced, Niger beans and Togo beans, which are distinguished by size and crease, are also sold. Ghanaians believe that eating the red-colored cowpeas will increase blood. Thus, red cowpeas are used as an ingredient in medicinal infusions.

We also noted bambara beans, which were more expensive than other beans and produced in northern and western Ghana. Groundnuts were transported from northern Ghana, while soya and broad beans were brought from various areas.

Excepting soya beans, beans are mostly used in stew for side dish. Soya beans were recently introduced into Ghana, and they are consumed as soya milk or a snack called *soya kebabu*.

Other protein sources

Local markets also carried fresh snails and smoked caterpillars. Snails are often used in Ghanaian dishes.

Konongo Market (Ashanti Region)

Konongo is the capital of Akim Central District, Ashanti Region. It is located along the trunk road, 53 km east of Kumasi, the capital of the Ashanti Region.

A large market is held every Tuesday in Konongo. We conducted field research in August 2012.

Roots, tubers, plantains, and cereals

We found plantains, yams, and rice at the market. The market has an especially large yam section. We did not notice cassava on the day we conducted our research; however, it is likely to be stocked on most days.

The market sold several varieties of yam, namely *pona*, *bayerepa*, *asobayere*, and *nkase-bayere*. While another tuber, *afasie*, is cultivated in this area, we did not see it at the market.

Furthermore, two types of plantain were sold, namely *apem* and *apentu*. There were two varieties of *apem* and three varieties of *apentu*.

We found several varieties of rice (*emo*), one produced in the Ashanti Region, and three others in different regions (one of them was from northern Ghana), as well as rice produced in China and Thailand. In addition, there was domestic crushed rice. Rice from northern Ghana was cheapest, and that from Thailand most expensive.

Domestic and wild animals

At the market, men sold fresh beef indoors, while women sold the dried meat of wild animals outdoors. Many stalls only sold pig toes. There was not much wild meat on sale, only small quantities of grasscutter and antelope. Grasscutter meat was more expensive than beef. From August to December, hunting wild animals is prohibited. Although we did not examine the cold store, frozen chicken and beef may be sold there.

Fish and aquatic produce

We discovered several types of smoked fish at the market, for example smoked freshwater fish such as *apatse* (smoked tilapia), *apalukusu* (smoked catfish), and smoked marine fish. Apparently, frozen marine fish is sold at the cold store.

Beans

We noticed that most beans were cowpeas, and that other beans were not really stocked at this market. Walking through the market looking for beans, we found only one store selling red cowpeas and Bambara beans.

The Market in Sunyani (Brong-Ahafo Region)

Sunyani is the capital of Sunyani Manicipal District and the Brong-Ahafo Region. There are several markets in the city. The largest is Nahahosuma market held every Wednesday. We conducted our research at Nahahosuma market and the Old market in downtown (to conduct research on wild animal meat) in August 2012.

Roots, tubers, plantains, and cereals

Plantains, yams, cassava, and cocoyam were sold at the Nahahosuma market. We found two varieties of *apem* and two varieties of *apentu*. There were several

varieties of yams, for example *drobeu*, *lily*, *pona*, *nananto*, and *monye*. These were produced in the northeast of the city along the trunk road. Located 100 km away, Kintampo was the farthest producing area. Furthermore, cocoyam and three varieties of cassava were found at the market.

There were few varieties of rice at the market. Some was produced in northern Ghana. While cereals produced in northern Ghana (probably pearl millet) were stocked, people in Suyani rarely eat them.

We also saw processed food, for example dried cassava with mold, cassava powder, and maize flour on sale.

Domestic and wild animals

Beef, cowhides, and smoked bat meat were sold at the Nahanosuma market. The only wild meat we found at the Nahanosuma market was bat meat, while fresh meat including grasscutter, antelope, and porcupine was sold at the Old market in downtown.

Fish and aquatic products

Marine and freshwater fish were sold at the Nahahosuma market. Marine fish were processed, mostly smoked, salted, or salted and sun-dried (*momoni*). Freshwater fish was smoked. Some freshwater fish was caught at Lake Volta. In addition, we noticed dried shrimps. Frozen fish was sold at the cold store.

Beans

Mostly, cowpea beans produced in northern Ghana formed the bulk of bean varieties sold. There were several varieties. In addition, we noticed red cowpeas, soya beans, Bambara beans, broad beans, and some unidentified beans at the market.

Other

Snails are sold at the market.

STATUS OF DOMESTIC PROTEIN CONSUMPTION IN GHANA

We observed the ingredients and cooking methods used in households in three areas of southern Ghana. Our observations were conducted in August 2010 and August 2012, during which time we stayed at a household for several days. At two of these areas, we conducted interviews to determine how frequently specific ingredients were used in main and side dishes.

There are two types of meals, namely a formal meal and snack. The formal meal comprises a main dish and a side dish. The main dish is made from root crops, cereals, or plantains, while side dishes are strongly flavored stews or soup containing boiled meat, fish, beans, and vegetables. The main and side dishes are served separately, although the side dish is occasionally put on the main dish.

Ingredients are classified as starchy foods, meats, fish, beans, green vegetables, oils, seasoning, and others below .

Kade Area (Eastern Region)

We conducted field research in Okumaning around Kade in the Eastern Region. We stayed at the Forest and Horticultural Crops Research Centre, University of Ghana's worker housing for five days, where we recorded meals and cooking methods. To do so, we asked informants to serve as many "ordinary" meals from the area as possible.

In Okumaning, we observed that main dish ingredients were plantains (*brodie*, called *koko* when mature plantain is used), cassava (*banchi*), maize (*eboro*), yams (*bayiri*), and rice (*emo*). There are various cooking methods: *ampesi*, steamed and boiled plantain and yam; *fufu*, boiled and pounded plantain and cassava; *banku*, grated cassava which is kneaded with water on fire⁽⁷⁾; rice balls, softly boiled rice shaped like a ball. In addition, we discovered many snacks: *gari*, grated cassava, which is pressed, sieved, and roasted; *kenky*, corn dough is kneaded, hot water added, then wrapped in maize leaves and steamed; maize porridge; rice porridge; roasted plantain; *red-red*, cowpeas boiled in palm oil and mature plantain fried with palm oil; *eto*, mashed mature plantain. *Gari* is distributed as a household industry commodity. Cooked *kenky* is sold at local markets. In addition, we found many cakes made from matured and non-matured plantain, because we told our informants that we were interested in plantains.

We noted the animal product ingredients used in side dishes, including: *kobi*, salted marine fish; smoked marine fish; fresh catfish; *Nam ya ho*, smoked bonito; *amane*, smoked herring; smoked freshwater fish such as tilapia; *koto*, sea club; beef; *wele*, cowhide; goat meat; guinea fowl; guinea fowl eggs; canned tuna; canned mackerel with tomato; and condensed milk.

We found two kinds of beans in side dish: cowpeas and groundnuts.

Two types of vegetables are used in side dishes. First, many vegetables are used as ingredients. Second, some vegetables are used for seasoning. Ingredients typically include cocoyam leaves (*kontonmule*), eggplant (*nyadua*), okra (*inkurma*), young leaves of *Corchorus* sp. (*ayoyo*), green beans (unripe fruit of cowpea), carrots, cucumber, and cabbage. Vegetables used to season side dishes include onions (*jen*), garlic, ginger (*akakaduro*), tomato (*tosu*), red pepper (*ameko*), and the fruit of a Solanaceae (*abedu*).

Two types of oil are used, namely red palm oil (*koukua*), a household industry product, and vegetable oil, an industrial product.

For seasoning and additive, we observed that salt (*intini* or *nkyeri*), Maggi stock cubes, white pepper, curry powder, nutmeg, pepper corn (African pepper, *Xylopia aethiopica*), tomato paste, and wheat flour were used.

The Kumasi Area (Ashanti Region)

Our field research on agriculture and food habits was conducted for five days in August 2012 at New Koforidua, located along the trunk road 24 km east of Kumasi. In 1946, migrants from Koforidua, the capital of the Eastern Region, founded New Koforidua. The town is currently inhabited by migrants from across Ghana. The most important cash crop in this area is cacao, and rice, palm oil,

lemons, and oranges are cultivated to earn cash. They also cultivate crops for their own consumption. The head of the household where we stayed was the child of migrants from the area around Bawku, the northern part of the Northern Region. Using a rented field, this family cultivates cacao, plantains, cassava, yams, cocoyam, red pepper, eggplant, okra, papaya, and so on.

Main dish ingredients we observed were plantains, cassava, maize, yams, and rice, similar to those used in Okumaning. Cooking methods in New Koforidua are similar to those in Okumaning, except for the absence of *banku*. Instead, we observed *akpele*, a dumpling made from kneaded maize flour.

Smoked fish (we do not know if it was marine or river fish) and fresh fish (mackerel) were served as ingredients for side dishes. Groundnut paste was also used. We did not observe the use of animal meat during the research period. Vegetables we noted included cocoyam leaves, okra, onions, tomatoes, and red pepper. Two types of oils, red palm oil and refined vegetable oil, were used. We ate roasted maize several times as a snack. We did not observe all cooking processes; thus, other vegetables and seasonings may have been used.

According to the family with whom we stayed, the most important protein source was fish, followed by beans, then meat. They could eat fish every day. Fresh and dried freshwater fish such as tilapia were frequently consumed. For beans, white and red cowpeas were frequently used as an ingredient. A few farmers cultivated white beans at New Koforidua. They rarely ate Banbara beans and soya beans. The most frequently consumed meat was goat meat, followed by chicken, beef, and wild animal meat.

Sunyani (Brong-Ahafo Region)

Sunyani is the capital of the Brong-Ahafo Region. We stayed in the city for five days, and had lunch and dinner at a government official's house several times. Here, they had planted cassava in the kitchen garden. In the fields in this neighborhood, we noticed cacao, plantains, cassava, cocoyam, taro, bananas, and maize planted for own consumption and to generate a cash income.

Ingredients for main dishes were plantains, cassava, and maize. These were cooked as *fufu* (plantain and cassava), *banku* (maize and cassava), *ampesi* (plantain), and *abetie* (dumpling made from kneaded dried cassava flour). Snacks included fried plantain (*koko ayachie*), *red-red*, and diced and fried mature plantain (*kelewele*).

Animal product ingredients for side dishes were fresh and smoked freshwater fish and grasscutter meat. We noticed only cowpeas for beans, and leaves of cocoyam for vegetables. Seasoning vegetables included okra, onion, tomato, ginger, and red pepper, while other seasonings included salt, palm oil, and a wild fruit called *mamia bedro*.

The interview revealed that the most frequently consumed main dish ingredient was plantains, followed by maize, yams, cocoyam, and cassava. Sweet cassava was more popular than bitter cassava. Fish was the most important protein source.

DISCUSSION

In this section, we examine the results of our research, which was conducted at markets and in households in the forest areas of Ghana. We also reviewed earlier literature. Here, we analyze the status of protein supply and consumption in Ghana's forest areas.

First, a large quantity of fish is distributed beyond regions. Transportation by truck is developed; thus, fish including frozen marine fish is distributed in neighborhoods bordering the forest areas. For transportation, fish are frozen, sun-dried, salted, sun-dried and salted, or smoked. Frozen fish is sold at cold stores, which sell only frozen food, while other processed fish is sold at local markets. According to Amoako-Kwakye, women in coastal areas such as Elmina process smoked marine fish industrially on a small or large scale. Herring and mackerel are generally processed on a large scale. It is reported that 79,700 tons of fish was smoked in coastal areas. A freshwater fish fishery prospers at the Volta River, and tilapia are frequently sun-dried and salted to preserve them (Amoako-Kwakye, 2010). These marine and freshwater fish are distributed according to certain routes, and a large quantity of marine fish is consumed in both inland and coastal areas.

Generally, meat is more expensive than fish, and less meat is distributed than fish. Consequently, households consume meat less frequently than fish. During our research, we rarely noted wild animal products sold at markets. We did see grasscutter, antelope, and porcupine a few times. One reason for the scarcity of wild animal products is the period during which we conducted our research, which was in the middle of August. In Ghana, hunting season closes from August 1 to December 1, and hunting is prohibited. Only permitted hunters may hunt for grasscutters during this time. The number of wild animals has decreased consequent to clearing forests for cacao fields and frequent forest fires. Closing the hunting season is one measure against the decreasing number of wild animals.

During our research, we discovered unique livestock products, for example dried cowhide cut into small pieces (*wele*). The meat of livestock is sold in an exclusive building where men dismantle and sell the products. As for fish, women sell cowhides and dried pig toes, which are used to enhance the flavor of various dishes, not as a protein source.

Regarding vegetable protein sources, beans are distributed and consumed in larger quantities in Ghana than in central Africa. While some farmers provide their own groundnuts, other beans are generally bought. Except in Accra, only cowpeas, referred to as normal beans, white beans, or red beans (according to color) are frequently found, and only a small quantity of Bambara beans are sold. However, in Accra, various beans including several cultivars of cowpeas from northern Ghana and neighboring countries are found.

Staple food, which is an important vegetable protein source, is locally distributed. Roots and plantains are cultivated in bush-fallow fields, young cacao fields, and kitchen gardens. There are a few large plantain plantations; however, plantains are usually cultivated by small farmers. Plantains are frequently planted in cacao fields the first year of cacao cultivation, and are harvested a few times while the

cacao trees grow. However, because plantains cannot be cultivated in mature cacao fields, the supply could decrease, even in rural areas, when no land is available for new cacao fields.

Based on statistical data, the rates for crop commoditization in forest areas are as follows: cassava (32.8%), yam (31.6%), plantains (36.5%), cocoyam (20.0%), and maize (57.8%) (Ghana Statistical Service, 2014). Excepting maize, these rates are low, indicating that farmers supply crop surplus to markets. Interviews conducted with farmers around Sunyani in the Brong-Ahafo Region suggest that farmers consume only 20–30% of their crops, while the remainder (70–80%) is sold or given away. The commoditization rate for yams in the savanna area is 65.9% (Ghana Statistical Service, 2014). Yams are cultivated on a comparatively large scale in the “yam belt,” which stretches from northern Brong-Ahafo Region to the Northern Region, from where it is distributed to forest areas including Accra. One reason for the wide distribution area is that yams are easily preserved than other tubers. Furthermore, rice production and import have recently increased, and urban Ghanaians often eat rice when dining out.

Following this analysis of the distribution and consumption of protein sources, we now consider the cultural and social value of food.

Comparing the meat, fish, and beans used in side dishes, at the market, meat is the most expensive, followed by fish, then beans. This order mirrors consumers’ preferences as well. For meat, wild meat is preferred, but it is scarce and expensive. Grasscutters are most frequently sold. Beans are sometimes regarded as poor people’s food. The most valued main dish ingredient is the yam, followed by plantains, cassava, and cocoyam. Rice consumption has recently increased rapidly, especially among urban young people who prefer fried rice for a light meal.

Generally, Ghanaians alternate main dish ingredients and cooking methods at every meal. Various cooking methods are adopted, such as *fufu*, *ampesi*, and *banku*. A peculiarity of side dish cooking methods is that several ingredients including multiple animal product foods are cooked together in one dish. We observed how guinea fowl, beef, goat, dried catfish, and fresh catfish are boiled together in one pot. Ghanaians prefer the taste of fermented salted fish. They also believe that crabs, shrimps, and cowhide add a deep flavor to side dishes. It seems they evaluate the complexity of the flavor of side dishes. Palm oil soup is the most popular soup. There are two types of palm oil soups based on the thickness of the broth, namely light soup and palm soup. We also often noted groundnut paste soup and okra soup, which generally contains palm oil. Ghanaians regard oil in soup as important.

Rules govern the combination of a main and side dish. *Fufu* is always eaten with palm oil or groundnut paste soup. Okra soup is generally served with main dishes made from maize or cassava such as *banku*. *Kenky* is often eaten with fried or roasted fish and grated onion, never with soup. These pairing rules are based on the history of ingredients and cultural taste preferences. As mentioned, rice consumption has increased rapidly, and protein intake will depend on whether fried rice without side dishes or steamed rice with soup is most often consumed.

Ghana’s forested areas are decreasing. Deforestation has decreased the supply

of wild meat. People in these forest areas take several measures against this change, such as developing a cold chain of imported chicken and frozen marine fish, and transporting fish processed in traditional ways—salted, sun-dried, or smoked—over a wide area. While cowpeas cultivated in the savanna are consumed to some extent, soya beans are not yet firmly established as ingredients of meals. Soya beans are rarely used for side dishes, but mainly for soya milk.

In central Africa, strong hunting pressure, deforestation due to an increasing population, and the establishment of reserves and national parks have gradually reduced available forest areas and wild animal supply to local people. Unique protein sources in central Africa's forest areas are two vegetable foods, namely cassava leaves and the leaves of *Gnetum* spp. (wild plants called iron leaves in some area). Both are good protein sources, as they have a high protein content and high amino acid scores.

The case of Ghana's forest areas demonstrates that decreasing forest areas, forest degradation, and the development of a distribution and commodity economy can rapidly decrease self-sufficiency related to protein sources such as meat, fish, and beans within districts or regions. Possibly, this can also occur in other forest areas in Africa, especially in central Africa. To increase or maintain a self-sufficient rate of protein sources, local people must reconsider small-scale freshwater fish aquaculture, small-scale livestock breeding including domesticating wild animals, and vegetable protein sources such as beans, cassava leaves and *Gnetum* leaves. When the government or NGO plan to introduce new foods such as soya beans, they should consider the suitability of these new ingredients for existing cooking methods and their cultural position. In addition, small markets should be constructed and maintained to distribute local products.

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NOTES

- (1) There are three months during which less than 60 mm of rain is measured in areas in the Brong-Ahafo and Volta Regions, and one month receiving less than 60 mm of rain in an area in the Ashanti Region.
- (2) Annual average forest reduction rates in the DRC and Cameroon from 1990 to 2000 are 0.4% and 0.9% respectively, and 0.2% and 1.0% respectively from 2000 to 2010.
- (3) Parts of the Volta, Eastern, and Western Regions are not forest areas; thus, this is an estimated rate. In addition, approximately 16% of Ghana's population resides in greater Accra.

- (4) For beans, the statistic for food supply in FAOSTAT (Food Balance) is less than that recorded in “Agriculture in Ghana: Facts and Figures 2012” published by the Ministry of Food and Agriculture, Republic of Ghana. We consider as correct the data published in the Ministry’s report (Ministry of Food and Agriculture, Republic of Ghana, 2013).
- (5) It is necessary to take into account the difference of water content among materials.
- (6) Fufu is a boiled plantain pounded with yam, cassava, or cocoyam into a ball shape.
- (7) Alternatively, corn or cassava dough is kneaded as an easier cooking method.

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